Notes and News

Mr. R. V. Cooke has been elected a member of the council of the Royal College of Surgeons of England.

Dr. Dorothy Shotton has been elected a member of the council of the Royal College of Obstetricians and Gynaecologists.

Dr. Allan Rogers, physiologist to the Trans-Antarctic expedition, has been presented with the triennial gold medal of the West London Medico-Chirurgical Society.

Dr. R. H. Parry has been appointed a member of the Local Government Commission for England under the Local Government Act 1958.

F.R.C.P.: John Apley, J. R. Bolton, J. J. Kempton.

F.R.C.O.G.: B. E. Blair.

WESSEX RAHERE CLUB

The Autumn Dinner will take place at Lansdown Grove Hotel, Bath, on Saturday, 31st October, 1959. Further details can be obtained from Hon. Secretary, Mr. A. Daunt Bateman, 11 The Circus, Bath.

EXAMINATION RESULTS

UNIVERSITY OF BRISTOL

Ph.D.

C. C. Berry

D.P.H.

Febry, G. N.
Gryspeerdt, M. J.
Kinnear, E.
Lumb, Kathleen M.
Nairn, G. J.
Ryan, R. P.
Wallace, Barbara A.

M.B., Ch.B.

WITH SECOND CLASS HONOURS

Clegg, Patricia C.
Golding, P. R.
Harries, Sara J.
Knapp, M. S.
Smith, Sylvia J.

PASS

Bracey, Anne F. M.
Carr, R. M.
Cooper, A. J.
Cooper, J.
Dada, Mollie
Davies, J. W.
De Garis, S. T.
Etuk, E. S.
Goffin, R. B.
Hakes, J. A. A.
Howard, Valerie J.
Lipscomb, C. F.
Lovell, Patricia M.
Magbagbeola, J. A. O.
Magnus, R. V.
Medway, T. A.
Nash, A. G.
Odutola, Oyinade O.
Panahy, C.
Pilton, D. W.
Stant, Patricia
Steiner, H.
Sykes, D. W.
Symes, M. O.
Voyce, M. A.
Wale, D. H.
Walker, Anna G.
Walker, I. R.
White, A. G.
Wilson, A. M.

PRIZES

Foyle Prize: Miss P. A. Clayton.
Mackie Pathology Prize: A. M. Wilson.
Edward Fawcett Memorial Prize: R. J. Paget.
Thomas Francis Edgeworth and Francis Henry Edgeworth Prize: C. E. Polkey.
Tibbits Memorial Prize: Miss A. G. Walker.
David Rayner Prize in Gynaecology: Dr. M. O. Symes.
Gold Medal in Child Health and Paediatrics: Dr. P. R. Golding.
Green-Armytage Prize in Obstetrics and Gynaecology: Miss S. J. Harries.

Appointments

R. F. Woolmer, director of the Department of Anaesthetics at the Royal College of Surgeons, has been appointed the first British Oxygen professor of anaesthesia by the College Council.

Flavia Z. L. B. Cooper, assistant anaesthetist, Royal Samaritan Hospital for Women, Glasgow.

M. V. Dunn, assistant M.O./school M.O., North Devon area.

R. Daphne R. Sasieni, Deputy M.O.H., Benfleet, Canvey Island, Rayleigh and Rochford.

L. P. Spence, pathologist (grade A), health department, Trinidad.

A. M. Bain, surgical registrar, West Suffolk General Hospital.

UNITED BRISTOL HOSPITALS
MARCH TO MAY 1959

Name	*Appointment*	*Formerly*
BRADFORD, Professor E. W.	Consultant Dental Surgeon (during tenure of the Chair of Dnetal Surgery in the University of Bristol).	Senior Lecturer in Preventive Dentistry & Parodontal Diseases in the University of St. Andrews.
JOHN, H. T., F.R.C.S.	Senior Surgical Registrar.	Senior Surgical Registrar, Royal Devon & Exeter Hospitals.
CROW, R. S., M.R.C.P.	Senior Medical Registrar.	Senior Medical Registrar, Royal Devon & Exeter Hospitals.
BOWDEN, B. J., D.O.	Senior Registrar in Ophthalmology.	Locum Outpatient Officer, Royal Free Hospital.
ADAMS, M. J. T., D.M.R.T.	Senior Registrar in Radiotherapy.	Registrar, Department of Radiotherapy, Middlesex Hospital.
WOOD, F. J. Y., M.D. (CANTAB).	Senior Registrar in Medicine (Cardiology).	Senior Medical Registrar, St. Thomas' Hospital.
MITCHELL, R. G., M.R.C.P.E.	Senior Registrar in Pathology.	Registrar, Department of Bacteriology, Newcastle.
WOODS, B., M.R.C.P.	Registrar in Dermatology.	S.H.O., Dulwich Hospital.
DANOS, E., M.B.	Registrar in Orthopaedics.	Locum Orthopaedic Registrar, Hospital of St. Cross, Rugby.
CARTER, Miss S. J., M.R.C.P.	Register in Radiology (Diagnostic).	Half-time Registrar in Radiology, United Bristol Hospitals.
JACKMAN, M., M.B., CH.B.(Bristol).	Registrar in Radiology (Diagnostic).	Half-time Registrar in Radiology, United Bristol Hospitals.
CLAREMONT, P. F., M.B., B.S. (Sydney).	Registrar in Radiology (Diagnostic).	Registrar in Radiology, St. Peter's Hospital, Chertsey.
O'MAHONY, J. B., B.D.S.R.C. (Q.U. Belfast)	Registrar in Dental Surgery.	Dental House Surgeon, Royal United Hospitals, Bath.

Dr. D. R. COLES, M.B., CH.B., M.D., M.R.C.P. has been accorded the honorary status of Senior Registrar in the Teaching Hospital during the tenure of his appointment as Second Lecturer in Medicine in the University of Bristol.

SOUTH WESTERN REGIONAL HOSPITAL BOARD
MARCH TO JUNE 1959

BRISTOL

Name	*Appointment*	*Formerly*
VELENTINE, M., M.D., D.P.M.	Consultant Psychiatrist, Bristol Mental Hospital Group.	Professor of Neuropsychiatry, University of Shiraz, Iran.
NAMBUDRIPAD, K. N., B.SC., M.B., B.S. (Madras), F.R.S.C.E.	Registrar in Department of Neurological Surgery, Frenchay Hospital, Bristol.	S.H.O., Department of Neurological Surgery, Frenchay.

Name	*Appointment*	*Formerly*
BAM, C., M.B., CH.B. (Cape Town).	Registrar in Obstetrics and Gynaecology, Southmead Hospital, Bristol.	Registrar, King Edward VIII Hospital, Durban.
HILL, B. W., M.B., CH.B. (Bristol).	Clinical Assistant in Dermattology, Cossham Memorial Hospital.	Is in general practice in Bristol.
WETHERED, H. H., B.A., M.B., B.CH. (Oxford).	Clinical Assistant in Dermattology, Southmead Hospital.	Is in general practice in Bristol.
LUMB, G. N., M.B., B.S. (Lond.), F.R.C.S. (Eng.).	Senior Registrar in Genitourinary Surgery, Southmead Hospital.	Surgical Registrar, Bath Group of Hospitals.
CHORLEY, G. E., M.B., B.S. (Lond.), D.A.	Anaesthetic Registrar, Frenchay Hospital.	Locum Registrar, Anaesthetics, Frenchay Hospital.
BIRD, R. L., M.B., B.S. (Lond.).	Registrar in Psychiatry, Bristol Mental Hospitals.	S.H.O., Bristol Mental Hospitals.
FOSTER, A. R., B.SC., M.B., CH.B. (Leeds), D.P.M.	Senior Registrar in Psychiatry, Bristol Mental Hospitals.	Registrar, Bristol Mental Hospital.
WESLEY-JAMES, O., M.B., B.S. (Lond.), F.R.C.S. (Edin. and Eng.).	Senior Surgical Registrar, Southmead Hospital.	Surgical Registrar, Radcliffe Infirmary, Oxford.
HANCOCK, D. O., M.B., B.S. (Lond.), F.R.C.S. (Edin. and Eng.).	Senior Registrar in Neurological Surgery, Frenchay Hospital	Registrar in Neurological Surgery, Frenchay Hospital.
LLOYD, A. T., M.B., CH.B. (Bristol).	Registrar in Psychiatry, Bristol Mental Hospitals.	R.M.O., The General Hospital, Otley, Yorks.
LESLIE, AGNES, M.B., B.S. (Madras), D.A. (Eng.).	Registrar in Anaesthetics, Southmead Hospital.	Resident Anaesthetist, Listei Hospital, Hitchin.
FORTUNE, D., M.B., CH.B. (Bristol).	Registrar in Pathology, Southmead Hospital.	S.H.O. in Pathology, Southmead Hospital.
DOLNY, L., B.M., B.CH., M.D. (Warsaw), D.P.M.	Assistant Psychiatrist, Bristol Mental Hospital Group.	Senior Psychiatric Registrar, Morgannwg Hospital, Bridgend.
WARREN, P. K. G., M.B., B.S. (Lond), M.R.C.P. (Lond.), D.P.M.	Assistant Psychiatrist, Bristol Mental Hospital Group.	Junior Hospital Medical Officer, Bristol Mental Hospital.
BRADFIELD, A. M., M.B., CH.B. (New Zealand), M.R.C.P. (Lond.), D.P.M.	Assistant Psychiatrist, Bristol Mental Hospital Group.	Senior Registrar, Barrow Hospital, Barrow Gurney.

NORTH GLOUCESTERSHIRE

Name	*Appointment*	*Formerly*
HOOPER, A. J., M.B., B.CH. (Wales).	General Practitioner Anaesthethist, Dilke Memorial Hospital, Cinderford.	General Practice, Drybrook, Glos.; Locum G.P. Anaesthetist, Dilke Memorial Hospital.
SELSNICK, FRANCES, L.R.C.P. & S. (Edin.), L.R.F.P.S.G., F.R.C.S. (Eng.).	Registrar in General Surgery, Gloucester Royal Hospital.	S.H.O., City General Hospital, Stoke-on-Trent.

BATH

Name	*Appointment*	*Formerly*
BOLT, G. L., M.B., B.S. (Lond.).	Registrar in General Medicine, Bath Group of Hospitals.	Locum Medical Registrar, St. Martins Hospital, Bath.

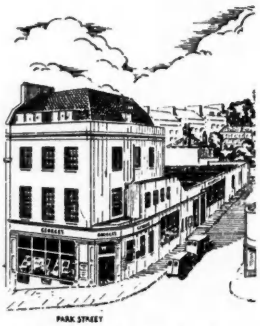
Name	*Appointment*	*Formerly*
BAZELEY, R. W., M.B., B.S. (Lond.).	Clinical Assistant in General Medicine in the Bath Group of Hospitals.	Is in general practice in Radstock.
BURROWES, W. L., M.D., B.CH. (Belfast), M.R.C.P.	Clinical Assistant in General Medicine in the Bath Group of Hospitals.	Is in general practice in Corsham.
ELLISON, D. J., M.B., CH.B. (Edin.), M.R.C.P.	Clinical Assistant in General Medicine in the Bath Group of Hospitals.	Is in general practice in Melksham.
PINCHING, J., B.M., B.CH. (Oxon), M.R.C.P., (Lond.).	Clinical Assistant in General Medicine in the Bath Group of Hospitals.	Is in general practice in Wells
DUCAT, E. F., M.B., CH.B. (Aberdeen).	Clinical Assistant in Paediatrics, R.U.H.	Is in general practice in Bathampton.
MUNRO, A. I., M.B., B.S. (Lond.)	Surgical Registrar, Bath Group of Hospitals.	Locum Registrar in general surgery, Bath Group of Hospitals.
KIRKUP, J. R., M.B., B.CHIR. (CANTAB), M.R.C.S. (Eng.), L.R.C.P. (Lond.).	Surgical Registrar, Bath Group of Hospitals.	S.H.O., Surgery, Manchester Royal Infirmary.
KILPATRICK, L. M.B., CH.B. (Edin.), D.(Obst.)R.C.O.G.	Re-appointed Registrar in Obstetrics and Gynaecology, Bath Group of Hospitals.	Registrar in Obstetrics and Gynaecology, Bath Group of Hospitals.

DEVON AND CORNWALL

Name	*Appointment*	*Formerly*
JONES, I. S., M.A., F.R.C.S.	Consultant General Surgeon, Plymouth.	Senior Surgical Registrar, King's College Hospital.
HERON, W. C., M.B., CH.B., B.A.O. (Belfast), D.M.R.D. (Liverpool), D.M.R.D. (R.C.P. & S.), F.F.R.	Consultant Radiologist, Exeter.	Asst. Radiologist, Leicester R.I.
GRAINGER, C. N.	Clinical Assistant in Dermatology, Exeter.	Is in general practice in Totnes.
GUERRERO, F., M.B. (Santo Domingo), 1955.	Orthopaedic Registrar, Mount Gold Hospital, Plymouth.	Senior Resident in Surgery, Hotel Dieu Hospital, Kingston, Ont.
BARTLETT, L. H., B.A. (British Columbia), M.D., C.M. (McGill, Montreal), L.M.C.C.	Orthopaedic Registrar, Mount Gold Hospital, Plymouth.	Resident in Orthopaedic Surgery, Vancouver General Hospital.
PANDEY, M. R., M.B., B.S. (Calcutta), M.R.C.P. (Edin.).	Medical Registrar, South Devon and East Cornwall Hospital, Plymouth.	Clinical attachments and courses Inst. of Neurology, National Heart Hospital, Brompton Hospital, Whittington Hospital, St. Mary Abbotts Hospital, Prince of Wales General Hospital, Tottenham.
BUNTING, J. B., M.B., B.CH. (CANTAB.), M.R.C.S. (Eng.), L.R.C.P. (Lond.), D.O. (Oxon), D.O.M.S. (Lond.).	Ophthalmologist, West Cornwall, Clinical Area.	Ophthalmic Practice Partnership and S.H.M.O., The London Hospital.
CREWE, T. C., B.D.S. (New Zealand).	S.H.D.O., South Devon and East Cornwall Hospital, Plymouth.	Assistant in general practice, Plymouth.

Name	*Appointment*	*Formerly*
DORAN, H. J., M.B., B.CH., D.L.O.	Clinical Assistant in E.N.T. Surgery, Torquay Group of Hospitals.	(*Extension of temporary contract for one session.*)
MCGHIE, J. A., M.B., CH.B., M.R.C.O.G.	Clinical Assistant in Venereology, Torquay.	—
CHATURVEDI, R. C., M.B., B.S. (India) 1944, D.O. (Oxford).	Ophthalmologist (S.H.M.O.), Devon and Exeter Clinical Area.	Locum S.H.M.O., Mid-Glamorgan, H.M.C.
NORRIE, D. M., M.B., CH.B. (St. Andrews), D.A.	Registrar in Anaesthetics, Plymouth.	Senior House Officer (Anaesthetics), Plymouth.

BOOKS



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BABY FARMING IN ENGLAND*

PHILIP EVANS, M.D., M.SC., F.R.C.P.

Children's Physician, Guy's Hospital, and Physician to The Hospital for Sick Children, Great Ormond Street, London.

A many years ago,
When I was young and charming
As some of you may know
I practiced baby farming.

H.M.S. Pinafore.

This song from Gilbert and Sullivan's *Pinafore* was for me all I knew of baby farming until a few years ago I met a baby farmer. The encounter stimulated my curiosity, and made me search for information about the industry. It was difficult to find: there is no textbook of baby farming, no Baby Farmers' Annual to tell the tale of the vicissitudes of the trade. Most of the information I have found is in old newspapers and journals, but some can be gleaned from Parish Registers, and there is now an excellent chapter on it in Leslie Housden's book *The Prevention of Cruelty to Children* (1955)[25].

First of all, what is baby farming? I take it to be the acquisition and use of infants for profit. But there is ordinarily no profit in the baby himself, for Dean Swift's plan for Ireland[1] has never been adopted. He put forward in an 18th century political satire: "A modest proposal for preventing the children of poor people in Ireland from being a burden to their parents or country, and for making them beneficial to the public". Swift had "been assured . . . that a young healthy child, well nursed, is at a year old a most delicious, nourishing, and wholesome food, whether stewed, roasted, baked or ragout". He calculated that 120,000 children of poor parents were born every year, and that 20,000 should be reserved for breed, and that the remaining 100,000 should be offered for sale to persons of quality and fortune. "A child will make two dishes at an entertainment for friends; and when the family dines alone the fore or hindquarter will make a reasonable dish, and, seasoned with a little pepper and salt, will be very good boiled on the fourth day, especially in winter".

Swift pointed out that his scheme would provide money for the family, make men as kind to their wives in their pregnancies as they were to their mares in foal and cows in calf, increase the national revenue, greatly lessen the number of papists, and incur no danger of disobliging England. Eighteenth century humour is rather strong for twentieth century stomachs, so let us be serious.

In other types of farming, the aim is to buy stock, fatten and sell it, breed from it, shear it, milk it, or in some similar way to make enough to cover the cost and leave something over. But thin, bald, milkless infants are unprofitable creatures, so the procedure is to get paid for taking the baby, and then to spend as little on it as possible. The most economic way of doing this is to kill it. This agriculturally reasonable procedure has roused a lot of opposition and made people write to the papers. It must not allow us to forget the other baby farmers who made a poor but honest living out of it, those described in the *British Medical Journal*[2] in 1868 as the "large number of perfectly respectable persons who eke out an insufficient living by taking charge of 'nurse children . . .' they do their duty to the children, and . . . regard their nurslings in a number of cases with feelings of tenderness and affection. More than this, we have been brought face to face with numerous instances of adoption of children from pure motives of tenderness, and from that yearning for the young which is one of the most sacred instincts of humanity".

*A lecture given to the Bristol Child Health Group on 12th March, 1959.

We read in *The Wealthy Virginian* by Hoole Jackson[20] "Colonel Jack was placed in the care of a nurse soon after his birth, and it seems likely that his father was a man of means, as a good sum of money was deposited with the chosen foster-parent for young Jack's upkeep and education. The nurse had been well chosen and told only that the name of the child placed in her care was John. She treated him as well as her own son, whose name was also John, and, to distinguish them, she nicknamed her own boy Captain John, and because young Jack claimed that as the son of a gentlemen he deserved a superior rank, she named him Colonel Jack.

"Aye," she told him, "you *are* a gentleman, and shall be a colonel. Captains are nothing. Every tarpaulin, if he gets but to be lieutenant of a press-gang, is called Captain, but gentlemen are ever made colonels, and I have known colonels come to be lords and generals."

Beside Colonel Jack and Captain John there was another boy—whether a son of the nurse or a child taken in to rear is uncertain—but he was nicknamed Major John, and these three were brought up in a kindly manner by the nurse. Unfortunately for them, she died when Colonel Jack was only ten years of age. The Major was then eleven, and the Captain eight. They were turned loose on London's streets, but soon learned to lie comfortably in shop-doorways in summertime, and ash-holes in winter, as well as how to pick up a living. From a comfortable home they were flung into a world such as that of Oliver Twist, peopled with Fagins, Artful Dodgers, and kidnappers, in the environs of Rosemary Lane.[20]

We may wonder what the motives are which make people pay to get rid of their babies, for it might be, as an unfortunate baby farmer wrote on the night before she was hanged in Horsemonger-lane gaol, that parents who sought to get rid of their children were more to blame than herself, and that if there were not such parents there would be no baby farmers.[3]

Vastly the greatest reason is of course, the stigma and inconvenience of having an illegitimate child. The unmarried mother looses her respectability and most of her earning ability at once. This was the basis of the thriving maternity homes of the suburbs of London in the nineteenth century, where, if abortion could not be arranged, the baby could be removed to a baby farm the day it was born, and the mother could return unencumbered and outwardly untarnished shortly afterwards. "I'm a jokelar person, I am; and I says funny things and cheers 'em up. She needn't mind, and mustn't fret, and I'll see her all right. I'm the old original, I am, and have had hundreds."[2]

Often people who cannot afford to keep their children cannot pay for someone else to have them, although the Day Nursery survives, rather better run than in "those nurseries in the manufacturing districts which are absolutely necessary" (Dickinson declared in 1870)[4]. These were Day Nurseries in which the children were quieted with narcotics (usually laudanum), "the nurse using them in the day to lull noise, which would otherwise convert the nursery into a Babel, the mother giving the dose at night, so that she may be fitted for her work in the factory on the morrow". A hundred years ago, outside some of those dark Satanic mills, the mortality rate for children under five years old was five times as high as in some rural districts. Dr. Edward Lankester, a coroner, believed that so large a proportion of illegitimate children were killed before they were one year old that there were few left on whom to hold inquests after that age (Housden, 1955).

Yet another economic reason for baby farming should be mentioned, although safe milk and the rubber teat have abolished it. At one time wet-nurses were paid 25 guineas a year, or 10 guineas a quarter, and many young women had children in order to earn money in this way. If they were unwilling to abandon their babies as foundlings, which was a criminal offence, they could clear themselves legally and financially by paying a baby farmer a small sum to take them.[5]

Early History

Baby farming, I suspect, must have existed for centuries, but a deputation sent by the City of London to Edward VI (1547–53) proposing that fatherless children should be nursed in the country had little success. The practice seems to have increased suddenly in the reign of his sister, Elizabeth I (1558–1603). It was a feature of the English Renaissance, like the glorious birth of the English stage and its poetry, the music of Byrd, nationalism, navigation, the Navy and the exploration of the New World, tobacco, potatoes, and the Church of England as by law established. In the parish registers of Chesham, Bucks, there are no entries of the burial of nurse children between 1538 and 1574, but in the next 64 years there were 45, mostly from London. In only one case was the name of the father entered, in some even the mother's is absent. Most came from London. Similarly in Lewisham and Sydenham's registers, the entries start in 1576 and are frequent from 1603; in St. Olave's and Bermondsey 1590 and 1591 are the opening dates; in Mitchem, 1587 (possibly 1586)[6]. In the next century Alton, Hants, Stoke Poges, Bucks, and Orpington, Kent, came into the picture. Mentions are common in the registers of places near London, and occasional near other large towns like Bristol and Norwich.[7]

For comparison I have gone through Registers in two parishes in the Sussex Weald and found only one case, recorded in unusual detail because of its special nature, I suppose. Its date is 1759, twenty years after Captain Thomas Coram established the Foundling Hospital.

> "June 19. Mercy Crull, an Infant belonging to the corporation of the Governors and Guardians of the Hospital for the Maintenance of deserted Children nurs'd by Sarah Pierce in this Parish."[21]

The rural practice was for illegitimate children to stay with their mothers, burials being recorded in some such terms as these:

> "1694. Mar. 31. Constance Bastard of that impudent whore Constance Mihels."[22]

A hundred years earlier Harris wrote:

"The Rector of a Parish twelve miles from London, with great relief of mind told me that his Parish, which was not small either in its Bounds or Number of Inhabitants and was situated in a very Wholesome Air, was, when he first came to it, filled with sucking infants, and yet in the space of one year he had buried them all, except two and one of his own whom being weak he had happily committed to my Care from his very Birth, and that the same Number of Infants being soon twice supplied, according to the usual Custom of hireling Nurses, from the very great and almost inexhaustible City, he had committed them all to their parent Earth in the very same Year . . ."[8]

Can one wonder that Blake[9] wrote in "Songs of Experience":

> Is this a holy thing to see
> In a rich and fruitful land,
> Babies reduced to misery
> Fed with cold and usurous hand?

The 19th Century and After

The first move against baby farming was started by that zealous reformer, Mr. Ernest Hart. In 1844, when a nineteen-year-old student at St. George's, he led the agitation which removed naval assistant surgeons from the cockpit to more fitting quarters.[10] In 1868, the forty-three-year-old editor of the *British Medical Journal*, ophthalmic and aural surgeon to St. Mary's Hospital, and Dean of its medical school, conducted an inquiry into baby farming in London and published the results in the *Journal*.[2] His method was simple: to answer advertisements in the newspapers for nursing homes where ladies "temporarily indisposed" could be received, and "baby can

be left"; then either Hart or Dr. Alfred Wiltshire visited the homes, ostensibly on behalf of clients, and conversed with the proprietors. He also advertised, offering to pay for the adoption of a child, and visited some of the 333 people who answered.

His reports described a number of thriving little businesses, some doing a good trade in abortions, others (disliking the risks of such affairs) preferring to allow the ladies to go to term, or at least to seven months, so that the baby could be neglected and be supposed to have been stillborn or to have died at birth. Adoption and disposal of living babies were frequently mentioned, and Hart also visited some unsavoury farms. He found the fees paid to maternity homes to be about £50, which would have allowed a margin for the baby-farming fee of £5–£10. "As the matter now stands" (he wrote) "there is not the slightest difficulty in disposing of any number of children, so that they may give no further trouble, at £10 per head . . . Demand and supply seem very equally balanced; and at this time there is certainly a very brisk business."

Hart's disclosures attracted some attention. In March 1868 Mr. Vanderbyl asked the Home Secretary in Parliament if he intended to put the law in motion to suppress the practices described in the *British Medical Journal*. The Home Secretary thought, that if the published statements were true they reflected great disgrace on the nation, but observed that the offences described were crimes within the law, and that it was not his duty to act as public prosecutor. The attention of the police had been called to the subject since publication of the articles.[11] Four months later Lord Shaftesbury asked a similar question in the Lords, and got a like answer from the Duke of Marlborough.[3]

Apparently nothing more was done, or would be done until the police produced evidence of crime. In 1870 a musician named Cowen and a Police Sergeant Relf appear briefly, and in the first case sadly and courageously, as Victorian social reformers.[3]

Cowen's unmarried daughter was about to have a baby. Cowen answered an advertisement of Margaret Waters, a widow of 35, who kept a baby farm at Brixton. Each advertisement cost Mrs. Waters 9s., in each she offered to adopt a child for a £5 note. Cowen arranged for his daughter (whom he called Mrs. Willis) to give up the child three days after he was born. Cowen appears to have become suspicious of the establishment, and he probably told his doubts to Sergeant Relf. This officer answered an advertisement, gained admission to the house, found nine children drugged with opium and in a miserable condition, and also 92 pawnbroker's tickets, mostly for articles of infants' clothing. Five of the nine babies subsequently died, among them young John Walter Cowen. Mrs. Waters was put on trial for his murder, and her sister Sarah Ellis was charged with conspiring to procure money by false pretences. She pleaded guilty and was sentenced to 18 months' imprisonment.

Waters' trial opened on 21st September at Newgate. She admitted that she had been in the business for four years, having started it in order to earn enough money to pay a debt, and that she had had "say forty" children confided to her. The largest amount of milk ever in the house was three pints a day. After a while "the poor little sufferers appeared to lose the power of crying". She denied intent to kill, saying the babies had died of convulsions or diarrhoea. After three days the trial was over, she was convicted and sentenced to death.

During her confinement in the gaol of Horsemonger-lane (a new model prison built as a result of Howard's reforms; Leigh Hunt enjoyed its hospitality) she conducted herself with a propriety befitting her position, although sometimes she despaired and was unable to take food. On the evening before she died she wrote an account on "three sides of a sheet of foolscap" explaining her method of livelihood. This document, which I would dearly love to read, may still exist in some clergyman's attic. In the night she slept for two hours, but restlessly. She rose and dressed at 7 o'clock in the morning, and spent the rest of her time with the chaplain. At nine the bell began to toll, and presently she left her cell and was conducted to the prison yard.

She helped the executioner to pinion her, mounted the scaffold unaided, and allowed herself to be placed for the drop. As the executioner adjusted the white cap and noose, she uttered a fervent and touching prayer for forgiveness. While the words were still on her lips the bolt was drawn, and she soon ceased to live.

A contemporary medical comment[4] was: "The sentence of death passed upon Margaret Waters will not act as a deterrent . . . Baby farming and baby-murder will go on as heretofore . . . the baby-farmers will raise their prices because of greater risks." Nevertheless 1871 saw the setting-up of a Select Committee of the House of Commons, and in 1872 an "Infant Life Protection Act" was passed. This provided for the registration of baby farms, but did not prevent baby murder, for no registration was needed if a woman took only one child; she could act expeditiously, and if the child died take another with impunity.[12]

In London baby farming was supervised, as well as it could be under the Act, and in 1894–5 there were 38 registered houses, in which the infant mortality was 10 per cent, but another 510 children were known to be kept in unregistered houses, and their mortality was 20 per cent. London had by then become unpopular with baby farmers, owing to the vigilance of the Public Control Department of the London County Council.[12]

Outside London only two houses were registered, one in Manchester and one in Bath, and it was clear that the Infant Life Protection Act did not protect the lives of illegitimate children, except to a limited extent in these two towns.[12]

In 1895 Lord Onslow introduced a new bill in the House of Lords, but it was so altered in the Committee stage that its sponsors withdrew it. Following a change of government, the bill was re-introduced by Lord Denbigh in 1896. Its fate seemed uncertain. The *British Medical Journal* ran an excellent series of articles showing the ineffectiveness of the Act of 1872,[12] and then fortunately (one may say without being callous) Mrs. Dyer was arrested in Reading. She took about £10 for each child. The bodies of five were recovered from the Thames or its tributary the Kennet.[13] Mrs. Dyer's fate is recorded in the ballad "Mrs. Dyer, The Baby Farmer",[14] of which one verse will serve as an example:

> Poor girls who fall from the straight path of virtue,
> What could they do with a child in their arms?
> The fault they committed they could not undo,
> So the baby was sent to the cruel baby farms.

Chorus:

> The old baby farmer, the wretched Mrs. Dyer,
> At the Old Bailey her wages is paid,
> In times long ago we'd ha' made a big fyer
> And roasted so nicely that wicked old jade.

The new act passed into law in 1897. It did away with many of the loopholes of the first act, but some still existed. It still did not apply to homes taking only one child: in 1903 it was calculated that four-fifths of the children were still not protected and that in one northern union a similar proportion of the one-child homes were unsatisfactory.[15] Prosecutions under the Act seem to have been rare, although in 1903 a woman was sentenced to two years' hard labour for abandoning three children of unmarried mothers (who had paid her £15–£20 each) in railway stations and trains.[12]

It was possible to dispose of babies without coming up against the Act at all. Consider, for example, the case of Walters and Sachs.[17, 18] In 1903 Sachs, a 29-year-old nurse, kept a maternity home in East Finchley, of which the newspaper advertisements said "baby can remain". Immediately after birth the infants were given to Walters,

54-years-old and also a nurse. Owing to the law's omission to supervise one-baby homes she had to act swiftly to make her living. She was under suspicion, probably between railway stations she felt a desire for coffee and a waitress saw her carrying a dead baby in a shawl. A police officer lodged in her house. One day she collected a baby, and gave it some chlorodyne. It died. She was followed by the policeman to South Kensington station (where, she stated, she was to meet the wife of the coast-guardman who wanted to adopt it,) and was arrested. Sachs and Walters were accused together at the Central Criminal Court. After a trial lasting two days the jury deliberated for forty minutes, found both women guilty of murder, and recommended them to mercy.

Mr. Justice Darling: On what grounds?

Foreman: Because, my Lord, they are women.[18]

They were sentenced to death. Walters wept but Sachs appeared unmoved.

According to the Act these women were not baby farmers: Sachs was the keeper of a maternity home and Walters an agent for transferring babies to foster mothers. They did not dispose of more than one baby at a time and so did not have to register the house—in any case they did not keep the infants alive for the statutory forty-eight hours; furthermore notification was only necessary if there was a down payment of less than £20, and Sachs and Walters charged £25–£30.[17]

In the new Children Act of 1908 this financial limit disappeared. Under the Act of 1948[19] the basis of the old Act was changed: it is the duty of the local authority not merely to regulate children's homes but to *assume the care* of children under certain circumstances, while it is equally the duty of the *parents to maintain contact* with the local authority and to contribute towards the child's support. Children's committees and children's officers must be appointed, but the clear placing of the responsibility on local authority and parents together, so that it is illegal to get rid of your child by passing a few five pound notes, is most important.

As you know, baby farming for profit has become rare. I wish we could say that it had disappeared, but as I told you I have met a baby farmer, and I have been told of a maternity home in Reigate from which, during the last war, babies were disposed of in the old way, but with some charge for maintenance (an incentive to keep the child alive) as well as a down payment, to homes in Yorkshire. Dickson[4] was not far wrong when he wrote in 1870: "Running from the highest to the lowest of the monied classes, a demand for nurses and nurseries will continue, and homes will still be open for the reception of infants, whose parents desire never to hear of them again . . . I believe it to be impossible for any law to wipe out this state of things altogether."

Nevertheless things are very much better. There are still many illegitimate births. The rate in England and Wales in 1871 was 17 per 1,000 unmarried women every year, but it had declined to 8 by 1911, and remained there (despite the war of 1914–18) until the 30's when it fell further to 5·5.[23] However, in the 1939–45 war it rose to nearly double and in 1955 was 9·4. These are the rates: as the population has increased by about two-thirds since 1871 there are nearly as many illegitimate babies born now as then. In England and Wales in 1955 there were 31,000 although a further 50,000 were probably conceived before marriage. 2,600 of the illegitimately born were legitimized by the subsequent marriage of their parents. Adoption has increased, in 1955 there were 13,000 legal adoptions, so that half the illegitimate children were legitimized or adopted. Children's Officers have to cope with the rest.

We here all like children for their own sake, but a falling birthrate makes governments value them more highly too, humanitarian feeling and political sense work together for the welfare of the infant. This might seem a threat to the continued existence of baby farmers but such resilient people need not repine. It is difficult to get a baby to adopt now, and in America the consumer shortage has reached such a pitch that large (but illegal) businesses have been built up to provide babies for a consideration.

When we open a newspaper nowadays we may wonder whether our active acquisitive civilization is progressing or just moving for moving's sake. In our care of children, even unwanted children, we can see some sign of forward progress, from darkness towards the light.

REFERENCES

1. Swift, J. (1729), From *The Works of Jonathan Swift, D. D.*, ed. D. L. Purves, Edin. 1876.
2. *Brit. Med. J.* (1868). **1**, 75, 127, 174, 175, 197, 234, 262, 301.
3. Annual Register (1870). Part II, 116, 120.
4. Dickson, T. (1870). *Med. Pr. and Circ.*, **10**, 323.
5. Garrison, F. H. (1929). *History of Medicine*, Phila. and Lond., 419.
6. Forsyth, D. (1911). *Proc. Roy. Soc. Med.*, **4**, Pt. I, 10.
7. Cox, C. J. (1910). *The Parish Registers of England*, London, 64.
8. Harris, (1689). De morbis acutis infant., quoted by Still, F. G. (1931). *The History of Paediatrics*, Oxford.
9. Blake, W. (1794). "Songs of Experience", "Holy Thursday".
10. *Dictionary of National Biography*, Suppl., Oxford, 1901.
11. *Brit. Med. J.* (1868). **1**, 276.
12. *Ibid.* (1896). **1**, 489, 543, 617, 670, 747, 796, 1109.
13. *Ibid.* (1896). **1**, 993.
14. *The Week-end Book*, London, 1955.
15. Brodie-Hill, W. L. (1903). *The Times*, Jan. 24th, p. 15.
16. *Brit. Med. J.* (1903). **1**, 221.
17. *Lancet* (1903). **1**, 250.
18. *The Times* (1903), Jan. 16th, p. 2; Jan. 17th, p. 5.
19. H.M.S.O. Children Act, 1948.
20. *Country Life*, May 27th, 1954. "The Wealthy Virginian" by Hoole Jackson.
21. Bolney Parish Register.
22. Cuckfield Parish Register.
23. Registrar-General's Statistical Review, 1937, Vol. II.
24. Registrar-General's Statistical Review, 1946–50.
25. Housden, L. G. (1955). *The Prevention of Cruelty to Children*, London.

THE USE OF AN ANIMAL LUNG AS OXYGENATOR IN A HEART-LUNG MACHINE

BY

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Much of the progress in modern cardiac surgery has been made possible by inventions which mechanically oxygenate blood outside the body and pump this blood back into the circulation—"the heart and lung bypass."

In 1955, when our work was first planned, the only successful heart and lung bypass reported in man was that of Gibbon (1953). A variety of other mechanical oxygenators were being developed, notably those of Melrose (1953), Bjork (1948), Denis (1951), Helmsworth (1952), Dodrill (1952), Jongbloed (1949), using either filming or bubbling as the method of oxygenation but success with these was, at that time, elusive and it seemed possible that there was some inherent defect in the direct exposure of blood to gas. There were also the obvious dangers of gas or fibrin emboli, the difficulty of cleaning large oxygenating surfaces and the bogey of the denaturing of proteins. Mustard (1952) suggested that the lung might also perform some essential function other than gaseous exchange. It seemed therefore that this method was worthy of further trial, and this paper records our experiences in using the lungs of one animal to oxygenate blood from another animal undergoing bypass operations.

Choice of species for animal experiments.—In most other laboratories the experimental animal for this type of work has been the dog. It seemed to us, however, that ruminants—calf, goat and sheep might have advantages over the dog. Among these advantages were larger vessels for cannulation, and a blood flow approaching that of man. With calf and sheep unlimited amounts of blood could be obtained from the abbatoir for priming the machine and for transfusion.

With animals of differing species to work with, it would be possible to test out heterologous lungs. Finally, if the method could be applied to man a lung about the same size as man's would obviously be an advantage.

METHODS

Preparation of the isolated donor lung was based on the technique described by Campbell (1956). The lungs were obtained on the day of the experiment, the technique varying however, depending on whether the goat or the sheep was the donor animal. (*a*) Goat lungs. These were obtained in the experimental laboratory using aseptic technique. To prevent clotting of blood in the lungs the goat was heparinized (150 mgm.) and anaesthetised with thiopentone. To avoid collapse of the lungs on opening the thorax and also inhalation of ruminal content, the trachea was exposed in the neck and clamped. The thorax was then opened and a clamp placed across the main pulmonary artery. The trachea was clamped high in the thorax and divided above the clamp. The heart and fully expanded lungs were removed from the chest by dividing the aorta, great veins and fibrous attachments. The heart, with the exception of a cuff of right ventricle around the pulmonary valve and the portion of left atrium receiving the pulmonary veins was cut away. The lungs were weighed. The main pulmonary artery was cannulated through the intact pulmonary valve using a perspex

cannula, and the clamp removed. By clamping the pulmonary artery before dividing any of the great veins and by having the perfusion fluid running continuously through the cannula, air embolism to the lung was prevented. In the earlier experiments the main pulmonary artery was cannulated directly: this proved less satisfactory, some air occasionally entering the artery. A second cannula was tied into the trachea and connected to a specially designed mechanical respirator (Clutton Brock 1957) which inflated the lungs intermittently with 100 per cent. oxygen at a pressure from 0–20 cm. H_2O, using a sine wave pattern. The lungs were then continuously perfused with dextran solution using the venous pump of the machine at a low flow rate (200–400 ccs. per min.). A depulsator was placed in the circuit proximal to the pulmonary artery to lower the pulse pressure. The mean pulmonary artery pressure was not permitted to exceed 20 mm.Hg. Five pints of dextran were recirculated through the lungs for 10–15 mins., then replaced by a further 5 pints and so on until the dextran remained clear. A total of 15–20 pints was required for a lung weighing 800–1,000 gms. Great care was taken to avoid air embolism during the washing and during the periods when recirculation was stopped ventilation of the lungs was also discontinued, because it was possible that ventilation without perfusion may result in air being sucked into the lungs from the open pulmonary veins (Campbell 1956—personal communication). In some earlier experiments a simple non-pulsatile gravity wash was tried. While this method provided effective washing it required a greater quantity of dextran. Gum saline solution was also tried as the perfusion fluid, but several lungs became severely oedematous during washing, and analysis showed the pH of the gum saline to be variable. When washing was judged complete a sample of the final effluent was taken for analysis of red cell content, and the machine and lung were primed with blood. The first 200 cc. of blood pumped from the lungs contained dextran and was discarded.

(*b*) Sheep lungs: These were obtained from sheep killed at the city abattoir. The animal was temporarily stunned by an electric shock and in approximately half the cases heparin was injected intravenously—to keep the animal subdued several shocks were necessary. The throat was cut and the animal bled to death. Before the butcher opened the thorax (about 10–15 minutes later) the trachea was clamped at the neck. After opening the thorax the technique was identical to that in the goat—the heart and lungs being removed by one of us. It was frequently found that the lungs were not fully inflated and, in later cases, the trachea was immediately cannulated, the lungs blown up by mouth and the tracheal clamp replaced. When this was not done the lungs were difficult to ventilate during washing. The heart and lungs were placed in a plastic bag and transported to the experimental laboratory. There was thus an unavoidable delay of an hour or more before washing was commenced.

Apparatus: The machine we used is shown in Fig. 1.

The pumping and control apparatus was that designed by Melrose at the Postgraduate Medical School, Hammersmith (Cleland and Melrose, 1955). A sloping container (S) held one or two pairs of lungs (L) and blood from the lungs drained into a calibrated perspex arterial reservoir (AR). Blood passed through the lungs, out of the open pulmonary veins and filmed down the slope into the arterial reservoir in an unbroken stream without frothing. A 100 mesh Monel wire filter was placed over the outlet from the arterial reservoir. The circuit contained in addition a priming reservoir (PR), a venous reservoir (VR) and adextran reservoir of siliconized glass (not shown). The depulsator (D) was made of a length of thin latex "Paul's tubing" two or three ply stretched between perspex fittings. An arterial and venous bubble trpa (ABT,VBT) were placed in the circuit distal to the arterial and venous pumps and pulmonary artery pressure was continuously monitored by an electromanometer *via* a side arm in the pulmonary artery line. The tubing was poly-vinyl chloride (3/8 ins. int.-diam.) and all extra connectors were of perspex designed to provide a continuous smooth lining and prevent turbulence.

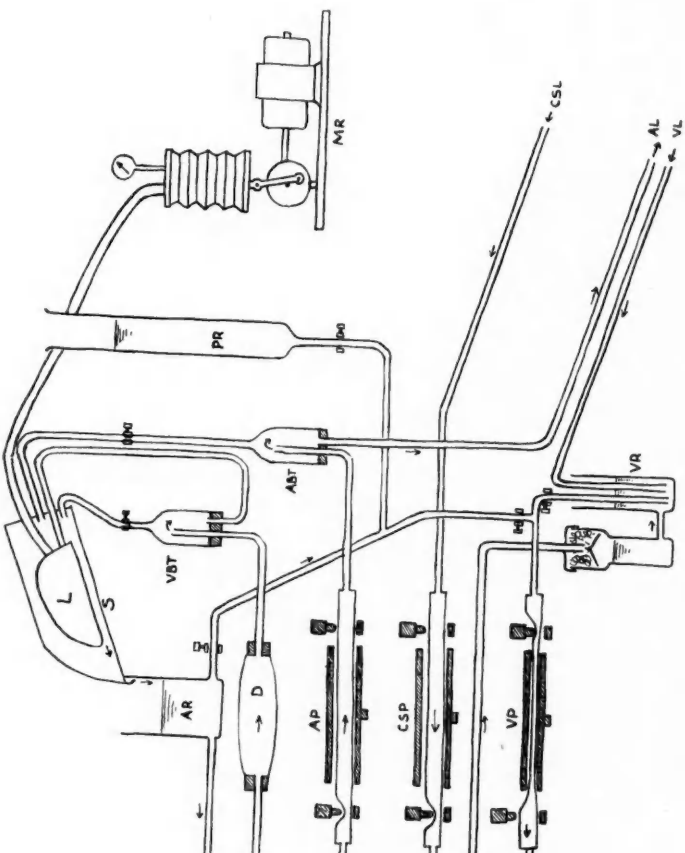


FIG. 1. *Diagram of Heart-Lung machine circuit. For description see text.*
VL = Venous line. VR = Venous reservoir. VP = Venous pump. D = Depulsator. VBT = Venous bubble trap. L = Lung. S = Sloping container. AR = Arterial Reservoir. AP = Arterial Pump. ABT = Arterial Bubble Trap. AL = Arterial line. CSL = Coronary sinus line. CSP = Coronary sinus pump. PR = Priming reservoir. MR = Mechanical respirator.

The apparatus was sterilized by standing for twelve hours in 1:10,000 benzalkonium chloride solution (Roccal). This was washed out first with tap water, then sterile saline. The venous pump was then used to wash the lungs with dextran *via* an additional connection between the arterial reservoir and the venous line. The machine and lungs were then primed with blood obtained on the morning of the experiment, 25 mgm. of heparin in 50 ccs. 5 per cent. dextrose solution being added to each pint.

During by pass the amount of blood contained in the isolated lung varied according to the rate of flow. In order to keep the amount of blood in the apparatus constant at different rates of flow during bypass the arterial reservoir was calibrated by pumping blood through the lungs at different rates of flow and noting the level of blood in the arterial reservoir. There was a difference of 200 to 350 ml. between the resting level and the level at a flow rate of 2 litres per minute. During perfusion the level of blood in the reservoir was kept at the level appropriate for the rate.

OPERATIVE TECHNIQUE USED IN ANIMAL EXPERIMENTS

In most experiments a calf from 1 to 8 weeks old (average weight 40 kg.) has been used as the subject for bypass operation, and lungs from a goat or sheep have been used in the machine. In a few early experiments a goat was used as the subject with goat lungs in the machine and in one case a sheep was used with goat lungs in the machine.

Premedication was with atrophine, and promethazine (phenergan). Anaesthesia was induced with thianbutone (ulbreval) and maintained, in the earlier experiments, with nitrous oxide and oxygen and small doses of thianbutone and later experiments with nitrous oxide and oxygen and a small amount of trilene. Also in later experiments an electric blanket was placed underneath the animal to counteract the fall in body temperature which occurred during perfusion. E.C.G. and E.E.G. records were taken before, during and after bypass operation.

The incision was in most cases a right thoracotomy through the fifth interspace with division of the 2, 3 and 4 costal cartilages. When this was completed heparin, 3 mgm/Kg, was given and the femoral artery and vein cannulated with fine polythene tubing for measurements of pressure in the abdominal aorta (by Hg. manometer) and inferior vena cava (by saline manometer). The right subclavian or carotid artery was then exposed and a cannula inserted into it and directed centrally. The superior and inferior venae cavae were then taped and cannulated through the right atrial appendage. The venous blood was drained by gravity into the venous reservoir placed six to twelve inches below the level of the right auricle. In the earlier experiments blood was aspirated direct from the cavae by the venous pump: following introduction of the gravity method a smoother higher flow was maintained and by varying the height of the venous reservoir the level of central venous pressure was easier to control, the rate of flow being adjusted to maintain a normal central venous pressure. Throughout the bypass the subject's lung was kept inflated, in the early experiments by clamping the intratracheal tube, and later by continuing rhythmic ventilation with nitrous oxide and oxygen. As the object of the experiment was to test the isolated lung oxygenator, a cardiotomy was done in only a few cases. Total heart-lung by pass was maintained in most cases for 30 minutes. The caval tapes were then released and pump rates gradually diminished. A fall of blood pressure occasionally necessitated a return to partial bypass and administration of nor-adrenaline. Great care was taken to maintain an accurate blood balance by equating operative blood loss with addition of blood to the circuit. After the cannulae were removed, 200 mgs. protamine sulphate was usually found to be sufficient to return the clotting time to normal. Both thoracic cavities were connected to underwater drainage for the first four to eight postoperative hours. Samples of blood were taken for electrolyte, pH, plasma Hb, cell counts and oxygen estimations. The saturation was measured by the pipette method of Roughton

PR = Priming reservoir. MR = Mechanical respirator.

and Schollander (1943) or by Handforth's method (1959) using an EEL colorimeter. Specimens were taken from the donor lungs after perfusion and from the lungs of the animals failing to survive.

RESULTS

An attempt was made to by-pass the heart and lungs in forty experiments.

In twelve experiments performed to gain technical experience a goat was used as the subject and goat lungs in the oxygenator. All these animals died. The lungs were not heterologous and the technique was elementary, so the results will not be given in detail; suffice it to say that in all cases the lung oxygenated satisfactorily and that in most cases death was due to obvious technical errors.

There were twenty-eight experiments in which an adequate flow was maintained with a heterologous lung for a sufficient time to assess its behaviour as an oxygenator. In all but one a calf was the operated subject. These experiments fall into two groups:

Group I—Oxygenator lungs taken from sheep in abattoir three hours or more before use.

Group II—Oxygenator lungs taken from goat in laboratory one and a half hours or less before use.

Group I. Heterologous Sheep Lungs. See Table I. In seven of the ten experiments, two pairs of lungs were used for the perfusion, connected in parallel. The delay before using these lungs was between two and three hours and ventilation of the lungs was often difficult, higher pressures being required than in the other groups. Dextran was used for washing in all cases. In the majority the wash, as judged by the red cell count of the final effluent, was not complete. In five experiments (Nos. 1–5) the sheep was not heparinized and in at least two of these some clotted blood was noted in the wash from the lung. Oxygenation was usually satisfactory although in three of the eight experiments where two pairs of lungs were used one pair was noted to be oxygenating poorly and was therefore excluded from the circuit. In Exp. No. 10 the single lung failed to oxygenate adequately after 10 minutes perfusion and developed gross oedema.

The development of pulmonary oedema in the oxygenator lung was less severe when the donor was heparinized: in these lungs the percentage weight increase was 42 per cent. while in the unheparinized it was 51 per cent. One animal in this group survived despite the development of gross oedema in the donor lung.

Group II. Heterologous Goat Lungs. See Table II. In all except No. 14 the goat was heparinised. By correctly timing the killing of the goat the lungs were used for the by pass in less than 1½ hours. The completeness of the wash was good in all cases, the red cell count in the final effluent falling as low as 3000 cells/c.mm. A cell count of 5000/c.mm. represented a dilution of the blood in the lung by 1/1000; if there were 200 c.c. of blood in the lungs before washing only 0·2 ccs. would remain to be mixed with the circulation of the subject. Oedema was insignificant or absent in thirteen, moderate or severe in five. The development of oedema seemed to bear no relationship to the duration of the perfusion or to the pulmonary artery pressure. Oxygenation was adequate even when oedema was severe.

On one occasion only, a dog lung weighing 240 gms. was used as oxygenator for heart-lung by pass of a goat. This experiment has been excluded from the tables. The extreme ease with which this lung was ventilated and washed and the pure whiteness of its surface after washing compared with the ruminant lungs was most striking. There was a delay of three hours before this lung was used and although it oxygenated well, marked oedema was present after 15 minutes by pass at a flow rate of 1200 cc/min.

TABLE I

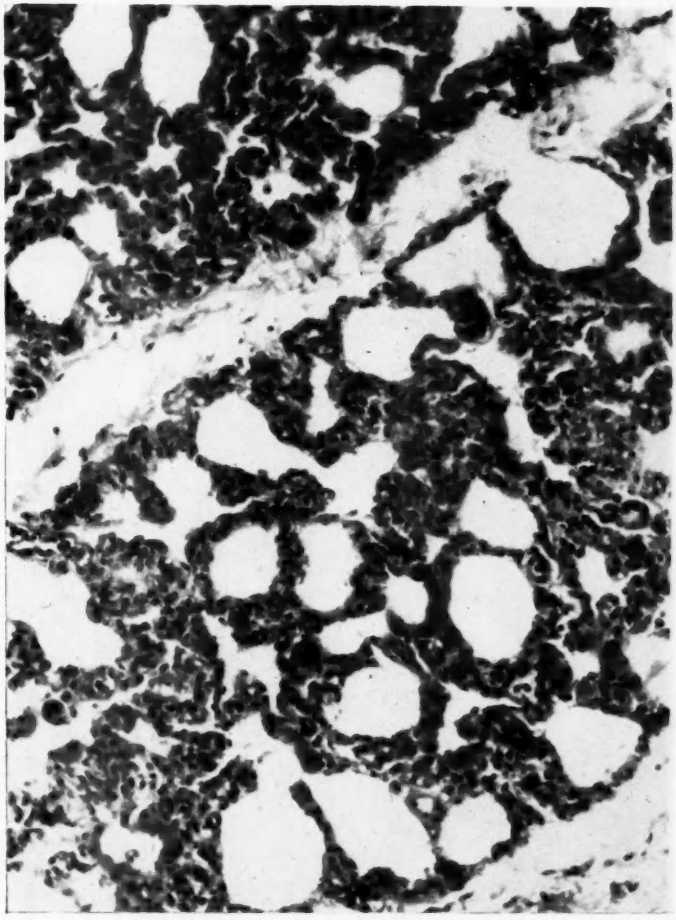
Sheep's lungs taken from abattoir and used within 2–3 hours in extra-corporeal circuit to perfuse *calf*.

Expt.: No.	Pairs of lungs used	Donar heparin-ised	Pulmonary artery pressure of perfused lungs (max. reading)	Quality of wash with Dextran	Duration of per-fusion in minutes	Blood flow cc./ min.	Oxygen-ation	Odema as per cent. weight increase	Fate of animal	Comment
1		+	60	Good	15	1,000	Good	80	Died on table	Air embolus
2	2	+	30	Good	15	1,000	100%	37	Died on table	Air embolus
3	2	+	15	Good	25	1,000	Good	25	Died during night	Pulmonary atalectasis
4	2	+	—	Fair	50	1,000	95%	42	Died on table	Ventricular fibrillation
5	2	+	45	Good	35	1,000	87%	26	Died 3 hours post. op.	Pulmonary atalectasis
6	2	—	50	Poor	32	1,000	Good	60	Died on table	Air embolus
7	1	—	40	Good	42	1,000	Good	70	Survived	
8	2	—	70	Good	20	1,000	85%	?	Died during night	Pulmonary atalectasis
9	2	—	80	Fair	30	1,000	80%	42	Died during night	Pulmonary atalectasis
10	1	—	—	Good	20	1,000	Poor	133	Died on table	Gross haemorrhagic pul-monary oedema during bypass

TABLE II

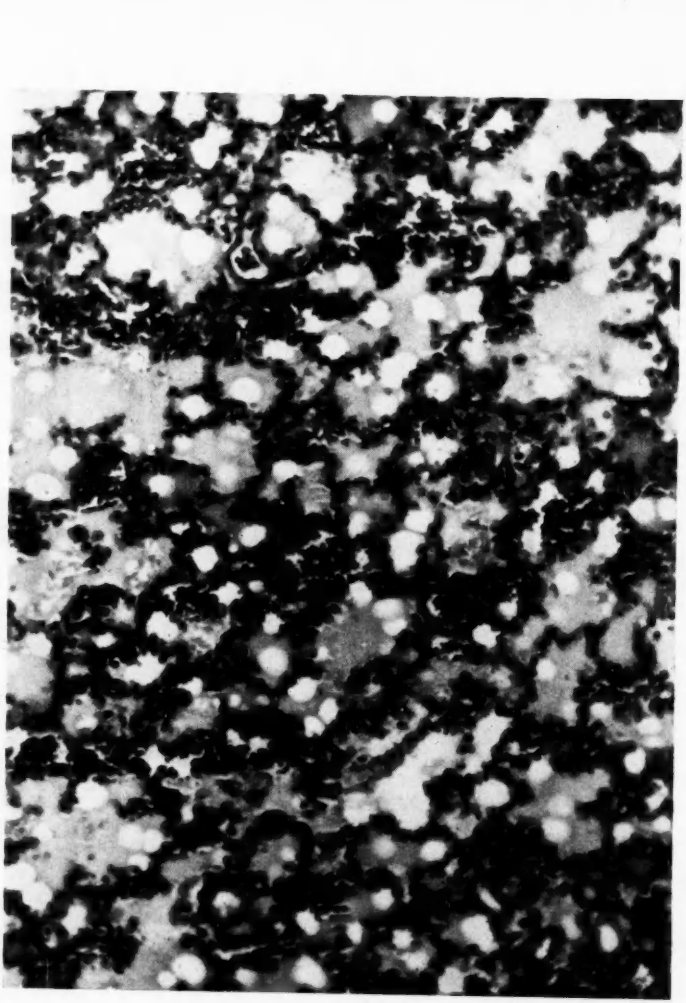
Goat's lungs taken in laboratory and used within 1½ hours in extracorporeal circuit to perfuse *calf*. (No. 27, was a sheep.)

Expt.: No.	Donor heparinised	Pulmonary artery pressure of perfused lung (max. reading)	Quality of Dextran wash	Duration of perfusion in minutes	Blood flow (max.) cc./min.	Oxygen per cent cent. satr.	Oedema as per cent weight increase	Fate of perfused animal	Cause of death of perfused animals
11	+	70	Good	27	1,000	98	None	Died 2 hrs. post-op.	Gross pulmonary oedema.
12	+	45	Good	27	1,250		None	Died 4 hrs. post-op.	Pulmonary atalectasis
13	+	50	Good	38	1,000	80	10%	Survived	
14	−	55	Good	30	1,000	68	None	Died 8 hrs. post-op.	Pulmonary atalectasis
15	+	40	Good	37	1,000		21%	Died 4 hrs. post-op.	Pulmonary atalectasis
16	+	−	Good	37	620	100	None	Died before wound closure	Gross pulmonary oedema
17	+	60	Good	38	1,250		None	Survived	
18	+	80	Good	52	1,000	96	29	Died 6 hrs. post-op.	Pulmonary atalectasis
19	+	70	Good	35	1,000	97	43	Died before wound closure	Gross pulmonary oedema
20	+	−	Good	50	500	94	112	Died during night	Mod. atalectasis
21	+	90	Good	26	1,000	92	36	Died during night	Mod. atalectasis
22	+	55	Good	30	1,000	98	47	Survived	
23	+	55	Good	36	1,000	92	100	Died 1 hr. post-op.	Haemothorax
24	+	95	Good	38	1,250	86	None	Died during night	P.M. not recorded
25	+	−	Good	41	1,000		40	Died during night	P.M. not recorded
26	+	−	Good	40	1,000		200	Died before wound closure	Gross haemorrhagic pulmonary oedema
27	+	−	Good	46	1,250	96	200	Died at end of op.	Would not start breathing again
28	+	−	Good	40	1,000		140	Died on table	Irreversible ventricular fibrillation



Microscopical section of lung taken from unheparinized sheep, perfused with dextran to wash out sheep's blood and then perfused with calf's blood for 42 minutes during the course of a heart-lung bypass—the calf survived. (Table I, No. 7). The Section shows marked interlobular oedema.

PLATE XXXV



Microscopical section of lung taken from a calf which died about 6 hours after complete heart-lung bypass for 25 minutes, using a sheep lung as oxygenator. (Table I, No. 3). The section shows severe alveolar oedema with a coagulated albuminous exudate blocking the alveoli.

Acid base balance: In nine experiments the pH of the blood was estimated at the end of perfusion: in six it was within the normal range (7·3–7·45), in one it was below normal (7·2) and in two it was above normal (7·47 and 7·53).

Electrolytes: In fifteen experiments in which proteins and electrolytes were estimated before during and after perfusion there were no significant changes in the sodium, chloride and protein levels. The potassium level was unchanged in eight, raised in five and lowered in two. In no cases were these changes of any magnitude.

Haemolysis: In twenty experiments the average reading for plasma Hb at the end of perfusion was 100 mg per cent.—the readings ranging from zero to 420 mgm per cent.

Platelets: In ten experiments in which the platelets were counted at the end of perfusion the counts were between 100,000 and 500,000 in seven, over 500,000 in two, and 70,000 in one. (The normal average for the calf ≡ 160,000).

E.E.G. Recordings: The electroencephalograph recordings excluded the presence of significant cerebral anoxia in all technically satisfactory experiments.

Fall in body temperature during perfusion. There was a fall in body temperature during by-pass averaging 4·4° C. Prior to use of the electric blanket the average temperature drop equalled 6°C. and after its introduction 3·5°C. The main cooling occurred as the blood passed through the lung; the lung was cooled during its washing with cold dextran and also by the oxygen with which it was inflated.

Histological appearances. Histological examination of the donor lungs after perfusion (Plate XXXIV) showed a variable degree of interlobular oedema and patchy collapse most noticeable in dependent parts of the lungs. The histological changes in the lungs of the calves dying after perfusion from apparent atelectasis (Plate XXXV) were of considerable interest. These lungs showed severe alveolar (not interstitial) oedema and haemorrhage, with fibrin plugs in the terminal bronchi in some places. The oedema fluid was highly albuminous and had coagulated, obstructing pulmonary ventilation very much in the same way as in hyaline membrane disease of the new born. The results of this was massive resorption collapse of the lungs and death. Similar changes however, were seen in the lungs of a calf dying after thoracotomy alone in which no perfusion had been done. (v.i.).

DISCUSSION

When a heterologous lung is used as oxygenator in an extracorporeal circuit it is necessary to wash out the native blood before perfusing it with the blood of the operated subject. The lung of the Rhesus monkey appears to be an exception to this rule because its blood is compatible with human blood, and Mustard has used it successfully in this way without prior washing.

The technique of preparing the lung for use is complex, and many points must be observed in order to get a good result. The following lessons were learnt:

(1) The donor animal must be heparinized before killing as otherwise it is impossible to avoid some clotting in the lungs.

(2) The lungs must not be allowed to collapse during removal because they are difficult to reinflate and may be damaged in the attempt.

(3) The washing fluid must be of the same pH and osmotic pressure as blood. Dextran was found ideal for this purpose, isotonic saline and gum saline both produced oedema.

(4) The dextran should be pumped through the lung at a mean pressure not exceeding 20 mm. Hg., a relatively smooth flow seems to be better than a pulsatile flow.

(5) In making the cannulations air embolus must be scrupulously avoided.

(6) During washing the lungs should be rhythmically inflated, the pressure of gas

must not exceed 20 cm. of water otherwise the alveolar membranes may be ruptured and pulmonary oedema will follow. (It was some time before we came to realize the importance of this point).

(7) Washing must be continued with repeated changes of dextran until the effluent is quite clear, about 15–20 pints are needed for the average goat lung. With care and attention to these details a lung almost completely free of blood and oedema was regularly obtained. It is worthy of mention that the dog lung seems to be easier to wash clean than that of the sheep or goat.

There should be as little delay as possible between the preparation and use of the lungs as an oxygenator. This requires careful timing and coordination. There is no doubt that the fresher the lung the longer it will stand up to perfusion without the development of oedema. Provided it is properly prepared and freshly used a goat lung can be relied upon to act efficiently as an oxygenator for 30 to 45 minutes with flows up to 1 litre per minute. Once oedema has begun to occur it develops fairly rapidly, though oxygenation may remain adequate for some time after the lungs have become obviously oedematous. Nevertheless oxygenation has been incomplete even when the lungs did not develop oedema to any extent. However, an oxygen saturation of 80 per cent. was found to be compatible with survival and in no case in which good flow was obtained did EEG evidence of cerebral anoxia develop. The results of analysis of pH, electrolyte balance and platelet survival lend support to the view that the heterologous lung produces no ill effect in an extra-corporeal circuit provided it is not used after it has become damaged by oedema.

On the debit side there are considerations of a practical nature which weigh heavily against the method. When applied to clinical use it is necessary to set up an animal operation theatre close to the main operating theatre for removal of the lungs under aseptic conditions. When the patient is an adult two animals must be sacrificed and two pairs of lungs taken. The introduction of two live calves or goats into hospital without causing undue comment presents problems! It takes 15 to 20 pints of dextran to wash out each pair of lungs, so that the cost in an adult case is about £30–£40 for dextran alone. The preparation of the machine for use takes several hours and it is not easy to co-ordinate with the surgeon so that both machine and surgeon are ready at the same time. The safe duration of the perfusion is from $\frac{1}{2}$–$\frac{3}{4}$ hour which, although long enough for most procedures, is not adequate for the more complicated cardiac anomalies that might come to surgery. Finally, during use the lungs become gradually oedematous and remove from the circulation an amount of fluid that cannot be estimated accurately until the lungs have been removed from the machine and weighed.

Considered in terms of survival these results have not been encouraging, for from twenty-five technically satisfactory experiments there were only four animals that survived completely. Lung complications were the commonest cause of death; five animals developed gross haemorrhagic pulmonary oedema either during or immediately after perfusion and died on the operating table (over-transfusion may have played a part in some of these but not in all). The remaining thirteen died some hours after operation, probably as a result of widespread resorption collapse of the lungs, due to a highly albuminous coagulated intra-alveolar exudate. No satisfactory explanation of these pulmonary deaths has been found. The possibility that it results from an anaphylactic reaction from foreign protein in the heterologous lung was rejected on the grounds that previous sensitisation was lacking. Furthermore a control experiment in which the operative part of the procedure was performed exactly as for perfusion but without any perfusion being carried out, (v.s.) showed that a major thoracotomy alone could be fatal in the calf, for this animal died within 12 hours and the lungs revealed the usual patchy collapse and familiar coagulated exudate within the alveoli. Ruminant lungs have a respiratory epithelium very prone to develop an exudative reaction. Perhaps the bovine species is particularly liable because pulmonary oedema occurs readily in cattle and can be due to a variety of causes, including mouldy forage, in-

jection of foreign proteins, toxins and chemicals. Pulmonary oedema may also occur during massive infestation with the lung parasite *dictyocollis*. Cattle being shown at Smithfield Show during 1952 "Smog" died of pulmonary oedema while other species were unaffected. Our results are therefore difficult to assess and a success rate of 14 per cent. does not necessarily condemn the method. Perhaps it is surprising that the isolated ruminant lung functioned as well as it did as an oxygenator.

SUMMARY

In twenty-eight experiments an isolated heterologous lung has been used as oxygenator in an extra-corporeal circuit.

Four animals survived out of twenty-three technically satisfactory experiments. Most of the deaths were due to pulmonary oedema to which ruminants seem to be unduly prone.

When carefully prepared, the heterologous lung has been shown to function well as an oxygenator. Practical considerations, however, weigh heavily against this method in human surgery.

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REFERENCES

Bjork, V. O. (1948). *Lancet*, **2**, 491.
Cleland, W. P., Melrose, D. G. (1955) Brit. Med. Bull. 11, 236.
Clutton-Brock, J. (1957). *Brit. J. Anaesth.* **29**, 517.
Denis, C., Spring, D. S., Nelson, G. E., Karlson, K. E., Nelson, R. M., Thomas, J. V., Eder, W. P., Varco, R. L. (1951). *Ann. Surg.* **134**, 709.
Dodrill, F. D., Hill, E., Gerisch, R. A. (1952). *J. Thor. Surg.*, **24**, 134.
Gibbon, J. H. Jr. (1953). *Recent Advances in Cardio-vascular physiology and surgery*, pp. 107–113. (Symposium presented by Minnesota Heart Association and University of Minnesota, Sept. 1953) Minneapolis, University of Minnesota, 1953.
Handforth, C. P., (1955) Lancet, 1, 1252.
Helmsworth, J. A., Clark, L. C., Sherman, R. T. Largen, L. (1952). *J. Thor. Surg.*, **24**, 117.
Jongbloed, J. (1949). *S.G.O.*, **89**, 684.
Melrose, D. G., (1953), *B.M.J.*, **2**, 57.
Mustard, W. T., Chute., Simmons, E. H. (1952). *Surgery*, **32**, 803.
Roughton, F. J. W., Scholander, P. F. (1943); J. Biol. Chem., **148**, 541.